# THE EFFECTS OF ANXIETY AND INTELLIGENCE ON CONCEPT FORMATION

BY

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FORM 412 1M 11-43

# THE EFFECTS OF ANXIETY AND INTELLIGENCE ON CONCEPT FORMATION

by

J. Peter Denny

Department of Psychology

Duke University

Date: May 30, 1962

Approved:

Charles D. Spielberger

Charles D. Spielberger, Supervisor

Karl Zener

C. A. Baylis

A dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor of
Philosophy in the Department of Psychology
in the Graduate School of Arts and
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# ABSTRACT

(Psychology-Thinking)

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Ph.D.
D412
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## ABSTRACT

The goals of this study were to investigate the effects of anxiety and intelligence upon proficiency in concept formation. On the basis of an extension of Spence's theory of anxiety and performance to incorporate intelligence as a variable, it was predicted that anxiety and intelligence would have interactive effects on proficiency in concept formation. This expectation was based on the assumptions that the effects of anxiety on proficiency would interact with those of task difficulty, and that task difficulty was a function of the intelligence of the subject as well as the intrinsic complexity of a task. Specifically, it was expected that if task complexity was held constant, higher levels of anxiety would facilitate concept formation for high intelligence subjects and impair concept formation for low intelligence subjects.

The subjects were 56 male students enrolled in introductory psychology who scored in the extreme quartiles on the Taylor Manifest Anxiety Scale. The high and low anxiety groups were each divided into high and low intelligence groups by splitting them at the median intelligence score for the total

group. This procedure yielded four experimental groups designated HiA-HiIQ, LoA-HiIQ, HiA-LoIQ, and LoA-LoIQ. All subjects were given two concept formation tasks, derived from those developed by Bruner, and required to deduce the attributes which constituted the concept from information provided as follows: the attributes included in the concept were deducible primarily by comparing negative instances of the concept to an initial positive instance, whereas the attributes not included in the concept were deducible by comparing positive instances to the initial positive instance. The necessary information was provided within the first nine instances; four additional redundant instances were given.

After the subjects had examined each instance, they were required to report their conclusions about the concept by recording either 1) that they knew the attribute was included in the concept (I), or 2) that they knew the attribute was not included (N), or 3) that they did not know whether the attribute was or was not included (?). The subjects' reports were scored correct or erroneous by comparing them to the report that could be correctly deduced from the information given by the instances presented.

The results for correct reports of knowledge of attribute inclusion showed that, as predicted, anxiety facilitated the concept formation proficiency of high intelligence subjects, and interfered with the concept formation proficiency of low intelligence subjects. This finding was explicated by examining the subjects' erroneous reports. Erroneous reports were divided into six error types depending upon the report made by the subject as

compared to the report that could be correctly deduced. Interactive effects of anxiety and intelligence were found only for those types of erroneous reports in which the information given established that an attribute either was (I) or was not (N) included in the concept but the subject made the wrong one of these two reports. The fact that this effect was found for only this kind of error was interpreted to be consistent with the extended theory of anxiety and performance.

Additional findings showed that high intelligence subjects and low intelligence subjects tended to make different types of errors in concept formation. For the first task only, high intelligence subjects made more erroneous reports than did low intelligence subjects of the type in which they reported that they did not know about the inclusion of an attribute in the concept (?), when they could have deduced that it was included (I). Low intelligence subjects made many more errors than high intelligence subjects of the type in which they reported that an attribute was included in the concept (I), when the information had not established whether or not it was included (?).

# ACKNOWLEDGEMENTS

I would like to express my very great appreciation to Dr. Charles D. Spielberger for his valuable aid throughout the course of this investigation and the writing of this report. I am also grateful to Dr. C. Alan Boneau for assistance at many stages of the investigation.

Thanks are due to Mr. David T. Wells and Miss Lou Ella Hicks for their help during the pilot studies leading up to this experiment.

This research was supported in part by Grant OM-362 granted to Dr. C. D. Spielberger and Dr. H. Weitz by the National Institute of Mental Health.

J. P. D.

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# THE EFFECTS OF ANXIETY AND INTELLIGENCE ON CONCEPT FORMATION

# INTRODUCTION

The goals of the present study were to investigate the effects of anxiety and intelligence upon proficiency in concept formation. The effect of anxiety upon concept formation was examined within the framework of a theory of anxiety as a motivating factor affecting performance (Spence, 1958). This theory was extended in the present investigation to encompass intelligence as a systematic variable. On the basis of the extended theory it was expected that anxiety and intelligence would have interactive effects on concept formation. Variations in intelligence were also expected to influence concept formation since the capacity for thinking and reasoning employed in concept formation is usually assumed to be an essential component of intelligence (Thurstone and Thurstone, 1941; Wechsler, 1958). After developing a brief theoretical description of concept formation, relevant findings concerning the effects of anxiety and intelligence upon concept formation will be reviewed.

## Concept Formation

Concept formation[1] has been characterized as a communication process (Bruner, Goodnow, and Austin, 1956, p. 233; Hovland, 1952) which begins with information which is given to the subject who is going to form the concept. The subject uses thought processes to translate this information into conclusions about the concept. This characterization of concept formation was amplified to produce a brief theoretical model which was suitable for the present experiment.[2] Within this model, a concept consists of a group of attributes; for example, attributes such as having wheels and having a motor make up the concept of a car. The attributes which are used in most concept formation studies are dimensional, i.e., each attribute is actually a class of sub-attributes which are called values. For example, the dimensional attribute "color" has the values "red," "blue," "green," etc. A concept consisting of dimensional attributes usually contains one value for each of several attributes, e.g., the concept of a wall might consist of the value "solid" from the attribute of density and the value "flat" from the attribute of surface plane. In a concept formation experiment the subject's task is to discover those attributes and their values which constitute

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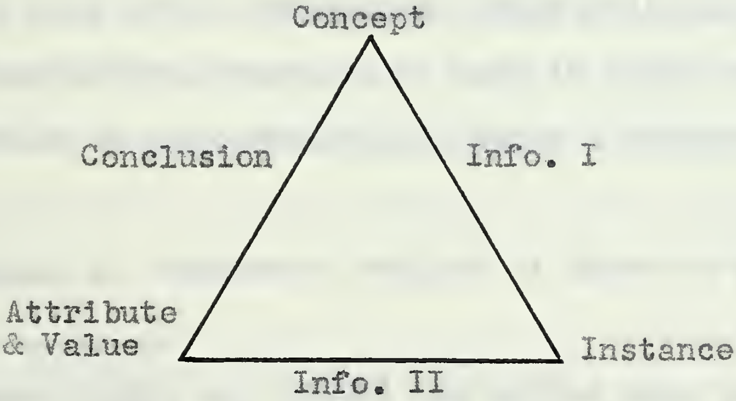
[1] Concept formation is also referred to as concept attainment (Bruner et al., 1956) and concept learning (Hovland, 1952).

[2] The description of concept formation in this experiment, although reasonably general, is best suited to conjunctive concepts (Bruner, Goodnow, and Austin, 1956, pp. 41-43; Hunt and Hovland, 1960); some modifications would be necessary in order to handle disjunctive or relational concepts. The present study used only conjunctive concepts, as defined in Chapter III.

the concept being formed.

In most concept formation experiments, the subject is given information which he can use to discover the attributes and values included in the concept. This information is conveyed primarily by means of objects presented to the subject. These objects possess both attributes and values, e.g., an object such as a car may possess the value "red" of the attribute "color." If an object possesses all of the attributes and their values which are in the concept, the object is called a positive instance. If an object does not possess all of the attributes and values in the concept, it is called a negative instance.[3] Since all objects used in concept formation experiments are either positive or negative instances, objects will be referred to hereafter as instances.

Two kinds of information are conveyed to subjects through the presentation of successive positive and negative instances. These are exemplified in the diagram below. The first kind of



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[3] A negative instance may possess some of the attributes and values in the concept. Also, regardless of whether the instance is positive or negative, it may possess attributes and values which are not in the concept, e.g., an object which is or is not an example of the concept "car" may possess the value "red" of the attribute "color."

information (Information I) tells whether an instance is a positive or negative instance of a concept, and is symbolized by the right side of the triangle in the diagram. Thus, Information I specifies the relation between an instance and a concept. In the present experiment, this information was given by the experimenter.[4] The second kind of information (Information II) specifies the attributes and their values which are present in a given instance, as symbolized by the base of the triangle. When each instance contains only one value of every attribute which is used, as will be the case in the present experiment, Information II specifies the particular value of each attribute which is contained in the given instance.

A subject translates information into conclusions which specify whether or not certain attributes and their values are part of a concept. These conclusions specify the relation of attributes and their values to a concept, as symbolized by the left side of the triangular diagram. To illustrate the notions developed in this brief theoretical description of concept formation, two hypothetical examples of ways in which subjects might use information to draw conclusions about a concept will be considered.

Example 1: Suppose a subject is shown an object which

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[4] Bruner (1956, pp. 17-21) has called this kind of information "validation." Grant (Grant and Berg, 1948; Gormezano and Grant, 1958) have referred to is as "reinforcement." These terms were developed for experiments in which a subject is asked to hypothesize whether an instance is an example of the concept or not, and then is told whether he is correct or not. To tell a subject whether he is correct or not is to validate or invalidate his hypothesis according to Bruner. To do this is to reward or punish (reinforce) the response used to express the hypothesis according to Grant.

he is told is a positive instance of a concept (Information I). From this instance the subject can obtain information about the value of each attribute which appears in the instance (Information II). He can combine both kinds of information with a suitable cognitive principle, i.e., a rule which he believes to specify a conclusion which can be correctly deduced from the information which has been given. In this example, a suitable cognitive principle would be: the value of an attribute appearing in a positive instance must be a part of the concept provided the concept contains this attribute. From the information and the cognitive principle the subject can draw the conclusion that, if a particular attribute is a part of the concept, its value in the concept must be the value shown in the given positive instance.

Example 2: Suppose a subject is shown two positive instances (Information I) in which the value of one attribute is different in the second instance from its value in the first instance (Information II). To this information he can add the cognitive principle: if an attribute has different values in positive instances, that attribute is not part of the concept. He can then draw the deductively necessary conclusion that the attribute in question is not contained in the concept.

## Experimental Studies of Concept Formation

Studies of concept formation may be examined with respect to the independent and dependent variables with which they are concerned. The dependent variables used in previous investiga-

tions are discussed in the next chapter, where the dependent variables used in the present study are presented. The independent variables used in concept formation studies may be classified into three groups: 1) individual difference variables, 2) information variables, and 3) process variables.

Process variables are concerned with the thought processes which mediate the translation of information into conclusions about the attributes in a concept, as illustrated by the cognitive principles in the hypothetical examples of the previous section. Process variables have received rather limited attention in experimental studies. There are two possible reasons for this fact, both stemming from the experiential character of thought processes. First, there are numerous technical difficulties in the manipulation and assessment of experiential variables. Second, as Zener (1962) has pointed out, psychologists of behavioristic persuasion have preferred to exclude experience from psychological investigations. Although Bruner, Goodnow, and Austin (1956) have made a fruitful start towards the study of process variables, by isolating "strategies" which are employed by subjects in concept formation, there are very few well confirmed findings.

Most experimental studies of concept formation have focused upon the effects of information variables (Archer, Bourne, and Brown, 1955; Grant and Curran, 1952; Kurtz and Hovland, 1956; Reed, 1946). This class of variables includes the two kinds of information described in the previous section, and other information such as the instructions for the task. Information variables

may be understood generally to contain what are commonly referred to as stimulus variables, which include the characteristics of the concept formation task and the environmental conditions under which the subject is working.

Individual difference variables such as anxiety and intelligence, which refer to characteristics of the subject who is forming a concept, have also received some attention in concept formation research. However, in most studies the focus of interest has been on the individual difference variable itself rather than on concept formation, i.e., concept formation tasks have been employed for the sake of what they might reveal about the individual differences in question. Studies of this sort have not contributed a great deal to the understanding of concept formation because of two major deficiencies. First, the individual difference variables selected for study were usually not simple psychological dimensions. Instead they were often complex categories such as the presence or absence of schizophrenia or of brain damage.[5] Second, as Hovland (1952) and Berg (1948) have pointed out, the tasks which were typically employed were complex sorting tests for which the information presented to the subject could not be clearly specified and the subject's conclusions about the concept could not be objectively assessed.

Recently, there have appeared a number of studies employ-

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5. Recent studies include, for schizophrenia: Chapman, 1956a; Chapman, 1956b; Yacorzynski, 1950; Hall, 1951; and Zaslow, 1950, and for brain damage: Jordan, 1957; Dolphin and Cruickshank, 1951; and Bressler, 1956.

ing individual difference variables in which the major focus of interest was concept formation. In these investigations anxiety and intelligence, the variables with which the present study is concerned, have been the most extensively studied.

Intelligence and concept formation. A number of recent studies have shown that proficiency in concept formation improved as a function of increasing intelligence. Hoffman (1955) demonstrated this relationship over a wide range of intelligence by employing groups of subjects whose mean IQs varied between 68 and 124. Similar relationships were shown in comparisons of normals and retardates (Griffith, Spitz, and Lipman, 1959; Korstvedt, Stacey, and Reynolds, 1954). Within narrower ranges of intelligence, comparable results have been found for intelligence differences restricted both to the mental retardation range (Stacey and Cantor, 1953; Stacey and Portnoy, 1951), and to the normal intellectual range (Baggaley, 1955; Osler and Fivel, 1961; Osler and Trautman, 1961). It may be concluded from these studies, first, that increasing intelligence leads to greater proficiency in concept formation throughout the intelligence range and, second, that differences in proficiency may be observed for relatively small variations in intelligence. While the former finding is not surprising, the latter indicates the sensitivity of cognitive performance to intellectual capacity and suggests the need for the inclusion of intelligence as a variable in studies of cognitive tasks, even when the population of subjects studied appears to be quite homogeneous.

Anxiety and concept formation. The majority of studies

of anxiety and concept formation have been carried out within the context of Spence's (1958) theory of the effects of emotionally based drive on performance. Spence has used the Taylor (1953) Manifest Anxiety Scale (MAS) to measure individual differences in anxiety or emotional responsivity. Emotional responsivity has been assumed to be a component of Hull's (1943) nonspecific or general drive, D, which combines multiplicatively with habit strength to produce excitatory potential. Since strength of response, in Hull's system, is determined by excitatory potential, as drive increases, response strength should increase. Thus, for a given habit, as anxiety increases, response strength should increase. Taylor (1951) first showed such a relationship for the conditioned eye-blink. This finding has been replicated for this task by Spence and Taylor (1951), Spence and Farber (1953), and Farber and Spence (1953).[6]

Spence's theory, as described thus far, predicted the effects of individual differences in anxiety on classical conditioning tasks which required subjects to learn a single isolated habit. However, studies of complex learning tasks such as serial learning and maze learning have shown that increased anxiety leads to poorer performance (Taylor and Spence, 1952; Farber and Spence, 1953; Lucas, 1952). The interpretation of these findings has required several additional theoretical assumptions. First, it was assumed that complex tasks elicit more habit tendencies

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[6] However, King, Kimble, Gorman, and King (1961) have failed to replicate these findings in two experiments. These authors suggest that anxiety must interact with other variables in its influence on performance, a view supported by the present study.

than simple tasks, and that, as a consequence, there may be a greater proportion of incorrect habits among the total number called forth. Second, it was assumed that as anxiety increases, the reaction potentials of the incorrect habits will be increased, so that, when an incorrect habit is dominant among all habit tendencies, poorer performance will result. The more detailed theory resulting from these supplementary theoretical notions has received direct support in two experiments. Montague (1953) varied the complexity of serial word lists to be learned by high and low anxiety subjects as a means of varying "the relative strength and number of the correct response tendencies as compared with those of the incorrect tendencies" which were elicited. On the most complex list, anxious subjects showed poorer performance than non-anxious subjects. On the least complex list, a second group of anxious subjects showed better performance than did non-anxious subjects. Spielberger, Goodstein, and Dahlstrom (1958) found similar results for the recall of difficult (complex) and easy (less complex) visual designs. Moreover, in the latter study, the same anxious subjects who showed poorer performance on the difficult tasks, compared to non-anxious subjects, also showed better performance on the easy tasks.

Investigations of the effects of anxiety on concept formation have obtained results somewhat like those for studies of anxiety and complex learning. However, the findings of these studies have not been entirely consistent and clear-cut. When anxiety has been induced by threat, subjects have shown decrements in concept formation proficiency (Dowis and Diethelm, 1958;

Beier, 1951; Tomblen, 1957). In experiments which have studied the effects of anxiety by selecting subjects with high and low scores on the MAS, the results have been more difficult to interpret. In only one study (Seigman, 1956) has a general decrement due to anxiety been found. In contradiction to this finding, Wesley (1953) obtained a non-significant improvement in concept formation proficiency due to anxiety. In those studies (Holbrook, 1954; Romanow, 1958; Lipman & Griffith, 1960) in which task complexity was varied significant interactions between complexity and anxiety were obtained.[7] In each case, anxiety led to impaired performance on the complex task, but only in Holbrook's study did anxiety lead to improved performance on the simple task. In their interpretation of these discrepant results, Lipman and Griffith have suggested the influence of individual difference in intelligency by citing unpublished data obtained by Deese (Deese, Lazarus, and Keenan, 1953). In two separate experiments Deese administered the same serial verbal learning task to persons of high intelligence and then to persons of somewhat lower intelligence.[8] He found that increased anxiety produced performance increments for the more intelligent subjects and performance decrements for the

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[7] Other studies have found interactions of anxiety with variables such as attribute type (Ate, 1955), practice (Williams and Corder, 1957), and order in which concepts are learned (Ate, 1955). These studies are described in more detail later in this report where they are more relevant.

[8] Intelligence was assessed by the socioeconomic and educational status of the two populations from which subjects were drawn.

less intelligent subjects. The possible role which intelligence may play in modifying the influence of anxiety upon concept formation will be discussed in the next section.

Anxiety, intelligence and concept formation. Two studies (Holbrook, 1954; Williams and Corder, 1957) have employed both intelligence and anxiety as independent variables. Besides reporting the interaction of anxiety and task complexity described in the previous section, Holbrook reported that his measure of intelligence, the American Council of Education Psychological Exam (ACE), correlated -.03 and .01 respectively with his two measures of concept formation. Williams and Corder also found no relationship between intelligence, as measured by the ACE, and concept formation. The failure of these studies to show that proficiency in concept formation improves with increasing intelligence appears to contradict the findings of a majority of the previously cited studies that have employed intelligence as a variable. These findings may be accounted for if Spence's theory of the effects of anxiety on performance is extended to encompass individual differences in general intelligence.

Spence (1958) states that the effects of anxiety depend upon the strength and number of incorrect response tendencies which are in competition with the correct response tendency. Since the hierarchies of response tendencies associated with most concept formation tasks are not readily specifiable, it is usually assumed that the strength and number of incorrect response tendencies elicited by a task is an increasing function of the complexity of the task. However, it would seem reasonable to assume

also that the number of incorrect response tendencies called forth in a subject by a task depends upon the subject's ability to cope with the task. A concept formation task of a certain degree of objectively specifiable complexity[9] when presented to a more intelligent subject may call forth only the correct conclusion about the concept whereas when the same task is presented to a less intelligent subject it may call forth many erroneous conclusions. In other words, the relative difficulty of the task differs for the two subjects; it is easy for the brighter subject and hard for the duller subject. Since both the objectively specifiable complexity of a task and the intellectual capacity of a subject may vary independently, task difficulty may be defined as a joint function of task complexity and the subject's intelligence. When the subjects in an experiment are unselected with respect to intelligence, individual differences in intelligency may be present which would produce correlated differences in task difficulty, i.e., brighter subjects will find the task to be less difficult. If anxiety is varied in the experiment, since anxiety has been shown to interact with task difficulty, we may predict that intelligence will interact with anxiety.

An interactive influence of anxiety and intelligence may have increased the variability of the subject's performance in

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[9] The complexity of a task may be objectively specified by referring to its structural aspects such as the similarity of words in a serial list, or the number of values possible for each attribute in a concept formation task. However, the point can be made that any definition of complexity is relative to a particular theory of complexity, or to the performance of some normative population on the task.

the experiments by Holbrook and Williams & Corder. Since neither study employed an experimental design which permitted the analysis of an anxiety by intelligence interation, variability due to such an interation may have obscured the expected facilitative effects of intelligence upon proficiency in concept formation.

In the present study, the influence of anxiety and intelligence upon concept formation was investigated within the framework of the extended anxiety theory described above, and by means of an experimental design permitting the isolation of the interactions between the independent variables.

## Statement of the Problem

The goal of the present study was to explore the effects of intelligence and anxiety upon proficiency in concept formation. The effects of anxiety on performance were expected to vary as a function of task difficulty, which was defined in turn as a function of the intelligence of the subject and the complexity of the task. In the present experiment task complexity was held relatively constant so that the influence of anxiety on performance would vary only as a function of intelligence. Thus, it was expected that anxiety and intelligence would have an interactive effect on concept formation proficiency. By employing tasks of appropriate complexity an attempt was made, in the present experiment, to show an anxiety by intelligence interaction in which anxiety facilitated the concept formation of the more intelligent

subjects and interfered with the concept formation of the less intelligent subjects. In addition to the interaction of anxiety and intelligence, it was expected on the basis of the repeated findings that intelligence facilitates concept formation, that higher levels of intelligence would produce more proficient concept formation. Thus, intelligence was expected to facilitate concept formation for both high anxiety and low anxiety subjects. A more precise statement of these predictions can be made after specifying those aspects of concept formation which are likely to show the predicted effects. To do this requires an analysis of the conclusions which a subject might draw concerning the attributes in a concept. This analysis is carried out in the next chapter.

# Chapter II

# THE EVALUATION OF CONCEPT FORMATION

The theoretical orientation presented in the previous chapter described concept formation as a process yielding conclusions about the attributes which are included in a concept. Within this view, the most desirable assessment of concept formation proficiency would be one which reflected both the process and the conclusions attained. Due to the lack of knowledge about the concept formation process it is more feasible at present to develop ways of evaluating a subject's conclusions. A new approach to evaluating conclusions in concept formation is presented in this chapter. However, before describing this approach it will be helpful to review previous measures of concept formation proficiency.

## Measures of concept formation used in previous studies

Two ways of assessing concept formation proficiency have been used in recent studies. In the first of these the subject

is required to report[10] whether he thinks the instance presented is positive or negative;[11] the number of correct reports over some set of instances is recorded. The subject usually makes his report by sorting the instance into a particular group (category) of instances (Wesley, 1953; Tomblen, 1957), pushing a particular button (Williams and Corder, 1957), or giving a verbal label (Romanow, 1958; Holbrook, 1954). The difficulty with this measure is that it may reflect several different aspects of the subject's thinking but fail to indicate by which of these it was determined. For example, the subject's report may be merely a random guess when he has not formed any conclusions about the concept; or his report may be based upon a hypothesis he has about the concept although he has not used any of the information provided him in forming this hypothesized concept. Another possibility is that the subject has used some of the information about the concept, in which case his report may be based upon knowledge of one or more of the attributes which are included in the concept, or knowledge of some of the attributes which are not included in the concept, or knowledge of some combination of included and unincluded attributes. All of these possible cognitive processes could yield the same report that the subject thought an instance was positive or negative.

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[10] The examples cited are drawn from studies of the influence of anxiety upon concept formation.

[11] The subject's report is a hypothesis about Information I (described in the previous chapter) prior to receiving that information.

Simpler variants of concept formation measures in which the subject reports whether he thinks an instance is positive or negative have also been used. The subject's knowledge of whether an instance is positive or negative has been assessed at the end of the experimental task by either counting the number of trials required for a subject to reach a specified criterion of correct reports (Holbrook, 1954; Wesley, 1953), or counting the number of subjects who reach the criterion (Dowis and Diethelm, 1958). This variant has all of the inadequacies of the original measure, plus the additional drawback of reflecting only the general level of a subject's performance over all the trials he has made. It cannot differentiate his skill at different stages of the concept formation process.

The second assessment of concept formation proficiency is the correctness or incorrectness of the concept which the subject has formed and which he reports at the end of the task (Williams and Corder, 1957; Lipman and Griffith, 1960). This measure, like the previous one, may be determined by but fail to differentiate among, several different cognitive states. Also, it is insensitive to the successive stages of the concept formation process.[12]

## Dependent variable used in the present study

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[12] Some authors (Cahill and Hovland, 1960; Bruner, Goodnow, and Austin, 1956, pp. 134-138) have taken this measure after each instance, i.e., they ask the subject to give his best guess about the concept after each instance, in which case this criticism does not apply.

One of the goals of the present study was to develop measures of concept formation proficiency which would reflect, in more detail, the conclusions which a subject derives about a concept from information given to him. Since, in concept formation experiments like the present one, the subject's task is to determine which attributes[13] are included in the concept, he can be asked to report what conclusions he has drawn in this regard. In the present study, three kinds of reports of knowledge of attribute inclusion were obtained. For a given attribute a subject could report 1) that he knew the attribute was included in the concept (which will be symbolized I), or 2) that he knew the attribute was not included in the concept (symbolized N), or 3) that he did not know whether the attribute was included in the concept or not (symbolized ?). Subjects inspected successive positive and negative instances and were asked to make reports of their knowledge of attribute inclusion for _each_ attribute after they had examined _each_ instance. This procedure provided a detailed record of the development of the subjects' knowledge about the attributes which were included in the concept as well as the attributes which were not included in the concept. In addition to meeting the two major criticisms

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[13] In the present study (following Bruner's practice) the first instance presented to the subject specifies the value of each attribute which must be included in the concept _if_ the attribute itself is included in the concept. Therefore, the subject's task is immediately reduced to determining which attributes are included in the concept. It is the subject's proficiency in this latter determination which is assessed in this experiment.

of dependent variables used in previous studies of concept formation, these measures were sensitive to and could differentiate among at least three kinds of knowledge on the part of the subject, i.e., that the attribute was included in the concept, that it was not included, or that the subject did not know whether it was included or not.[14] This measure was also sensitive to changes taking place during the development of the subject's knowledge of the concept. These changes could occur along two dimensions: from instance to instance (isomorphic with the time dimension) and among attributes.

Reports of knowledge of attribute inclusion were converted into a measure of proficiency of concept formation by comparing a subject's reported knowledge to a criterion of correct knowledge. A subject's reports were scored correct or incorrect by comparing them to the knowledge of attribute inclusion which he could have correctly deduced if he made complete use of the information provided him.[15] For example, if the information given to the subject had established that a certain attribute

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14. The knowledge of attribute inclusion measure can be modified to become sensitive to other kinds of knowledge, e.g., the subject can be asked to report if he knows that one of two or more attributes must be included in the concept, but he does not know which one.

15. Many criteria other than maximum deductively correct knowledge are possible, although they are technically more difficult to specify. For instance, a model of correct inductive knowledge could be set up, or correct reports in accordance with the use of a particular set of cognitive principles (akin to Bruner's strategies) could be used.

was not included in the concept, and the subject reported that he knew the attribute was included in the concept, he would have made an error. Furthermore, he would have made an error of a certain type, since all of the subject's correct and erroneous reports of knowledge of attribute inclusion can be categorized into a systematic typology.

The various types of correct and erroneous reports may be tabulated in the following way. The three kinds of conclusions (I, N or ?) which a subject can report may be compared to the three corresponding kinds of conclusions which may be correctly deduced from the information given to the subject. The information provided about an attribute may establish that it is included in the concept (symbolized /I), that it is not included in the concept (symbolized /N), or that insufficient information has been given for a conclusion to be correctly drawn (symbolized /?). All possible comparisons of a conclusion reported by a subject and a conclusion deducible from the given information may now be tabulated. In the table below a comparison of a subject's conclusion and a deducible conclusion is symbolized as follows: if a subject concluded that an attribute was included in the concept (I) and the information established the conclusion that the attribute was not included in the concept (/N), this comparison is written "I/N." The first letter gives the subject's reported conclusion and the second gives the conclusion deducible from the information given.

The table shows that there are nine simple types of comparisons between subjects' conclusions and deducible conclu-

| | | /I | /N | /? |
|---|---|---|---|---|
| SUBJECT'S CONCLUSIONS | I | I/I | I/N | I/? |
| | N | N/I | N/N | N/? |
| | ? | ?/I | ?/N | ?/? |

DEDUCIBLE CONSLUSIONS

sions. In three of these comparisons (those shown in the unshaded cells), the subject's conclusion is the same as the conclusion obtainable through maximum correct deductive use of the given information. Therefore, the subject's conclusion is correct. In the remaining six comparisons (those shown in the shaded cells), the subject is in error. Each comparison may be regarded as a measure of a different aspect of a subject's conclusions about a concept, and may be quantified by counting the frequency of its occurrence.

The measures used in the present study were based on these nine comparisons of subject's conclusions with deducible conclusions. The first measure was the sum of the frequency of occurrence of the three correct types of comparisons. This measure was designated "total correct reports." Total correct reports counts the number of times a subject draws the conclusion which was correctly deducible from the information provided him. The other six measures were the frequency of each of the six erroneous types of comparisons. These were designated: "I/N errors," "N/I errors," "I/? errors," "N/? errors," "?/I errors,"

and "?/N errors." The meaning of the six error types and the aspects of a subject's conclusions assessed by each may be explicated by grouping them in pairs. These pairs are set off by the heavy dividing lines in the table. The first pair, I/N errors and N/I errors, and the second pair, I/? errors and N/? errors, may be called "commission errors" because they each occur when a subject concludes that an attribute is either included or not included in a concept. The first pair, I/N and N/I errors, may be further delineated as "commission errors with information given" because they occur when a subject has been given sufficient information to conclude that an attribute either is or is not included in a concept. The second pair, I/? and N/? errors, are "commission errors with no information given" since they occur when a subject has not been given sufficient information to conclude whether an attribute is or is not included in a concept. The third pair of error types,?/I and ?/N, are "omission errors" because the subject concludes that he does not know whether the attribute is included or not, although he has been provided with sufficient information to establish a definite conclusion.

## Experimental Hypotheses

The experimental hypotheses of the present study may be expressed in terms of the measures of accuracy of knowledge of attribute inclusion developed above. First, it was expected that anxiety and intelligence would have an interactive influence

upon total correct reports: anxious subjects of high intelligence were expected to give more total correct reports than nonanxious subjects of high intelligence, whereas anxious subjects of low intelligence were expected to give fewer total correct reports than nonanxious subjects of low intelligence. Second, it was predicted that subjects of high intelligence would give more total correct reports than subjects of low intelligence. Additional data explicating these predicted findings was expected from analyses of the effects of anxiety and intelligence on the six error types.

# Chapter III

# METHOD

## Experimental Design

The design employed two levels of each of the independent variables: high and low anxiety, and high and low intelligence. Anxiety was measured by the Taylor Manifest Anxiety Scale (Taylor, 1953) (see Appendix A), hereinafter referred to as the MAS. This measure was chosen because it was developed for use in experiments based upon Spence's theory of anxiety and performance, and because it has been employed in most of the investigations of concept formation based on this theory. General intelligence was measured by the College Entrance Examination Board Scholastic Aptitude Test (CEEB). The measure used was the sum of the CEEB verbal and mathematical aptitude scores. This measure of intellectual capacity was chosen because it was already available for most subjects, and because it is more sensitive to differences in intelligence within highly intelligent populations such as college students than are standard intelligence tests. An additional dimension was introduced into the design by the use of two concept

formation tasks which varied somewhat in complexity. The two individual difference variables, anxiety and intelligence, were between subjects variables and the two tasks constituted a within-subjects variable, i.e., each subject did both tasks.

Subjects

Four groups of subjects were selected from male[16] students in introductory psychology at Duke University in the following manner. First students were selected who scored in the upper and lower quartiles of the MAS distribution for male students (MAS raw scores of 20 and above, and 8 and below). Subjects who were likely to have faked spuriously low MAS scores were excluded from the sample by eliminating students who had scores of 8 or above on the L-scale of the Minnesota Multiphasic Personality Inventory. In addition, several subjects for whom CEEB scores were not available were eliminated. The 67 students (32 with high MAS scores and 35 with low MAS scores) who served as subjects[17] in the experiment were divided into high and low intelligence groups by splitting them at the median intelligence score (CEEB score = 1156) for the total group. The resulting groups were

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[16] Only men were used because some investigators (Heilizer, Axelrod, and Cowen, 1956) have found different relationships between anxiety and complex tasks with men than with women.

[17] Eighty-seven subjects scored in the extremes of the MAS distribution. Of these 71 served in the experiment; four were subsequently eliminated, 3 due to errors in the administration of the experiment, and 1 because he seriously misunderstood the task.

designated HiA-HiIQ (N = 16), LoA-HiIQ (N = 19), HiA-LoIQ (N = 16), and LoA-LoIQ (N = 16). It was observed that both LoA groups had slightly higher intelligence scores than the corresponding HiA groups;[18] therefore, solely on the basis of the subjects' CEEB scores, and independent of the subjects' concept formation proficiency scores, subjects were eliminated from each of the four groups so that 1) the HiA group at each level of intelligence was matched for mean intelligence score with its corresponding LoA group, and 2) the four groups were of equal size (N = 14 for each group). The mean intelligence and anxiety scores for the four groups used in the study are shown in Table I, in which it may be seen that the anxiety groups were well matched for intelligence. Although no special steps were taken to equate the intelligence groups for anxiety scores, Table I shows that this matching was satisfactory.

## Tasks

Two concept formation tasks were given to each subject. An example of the sort of task used in the experiment is shown below; the example consists of instances 1, 2, 3 and 4 from Task 2.[19] Each task consisted of 13 instances constructed from

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[18] Spielberger (1958) also found small negative correlations between MAS scores and intelligence scores for male college students.

[19] The two tasks are shown in Appendix B along with their informational properties and details of their construction.

Table 1

MEAN ANXIETY, AND MEAN INTELLIGENCE SCORES FOR THE FOUR SUBJECT GROUPS

| Group | MAS | CEEB |
|---|---|---|
| High Anxiety - High Intelligence | 23.9 | 1270 |
| High Anxiety - Low Intelligence | 23.7 | 1033 |
| Low Anxiety - High Intelligence | 5.4 | 1270 |
| Low Anxiety - Low Intelligence | 4.1 | 1042 |

| | $\boxed{\text{A}}$ | B | $\boxed{\text{C}}$ | $\boxed{\text{D}}$ | E | $\boxed{\text{F}}$ | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 + | $\boxed{/}$ | * | $\boxed{/}$ | $\boxed{:}$ | / | $\boxed{:}$ | * | * |
| 2 + | / | / | / | : | / | : | * | * |
| 3 + | / | * | / | : | : | : | * | * |
| 4 - | / | * | / | : | / | / | * | * |

eight attributes where each attribute had three possible values. The attributes were lettered positions (columns) on an 8½" x 11" sheet of standard white bond paper, going from A on the left to H on the right. The values were common typewriter symbols, herein referred to as line (/), star (*), and colon (:).[20] The instances were rows of symbols, one symbol placed at each lettered position. The instances (rows) were typed one beneath the other in the order in which they were presented to the subject; they were also numbered in this order. Each instance was marked with either a plus (+) sign which indicated that it was a positive instance or a minus (-) sign which indicated that it was a negative instance. Each problem began with an initial positive instance.

There was one conjunctive concept[21] to be formed in each concept formation task. Each concept specified particular values for particular attributes, e.g., in the above example the concept was A(/) C(/) D(:) F(:); the attributes and values in the concept are shown in boxes. Inspection of the example shows that the

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[20] 20. Since increased amounts of information which the subject must remember have been found to interfere with concept formation (Cahill and Hovland, 1960), a key to the symbols used to represent the values was provided at the top of each task sheet.

[21] 21. A conjunctive concept is a concept whose positive instances must show all of the attributes and values in the concept.

positive instances (rows 1, 2 and 3) contain all of the values in the concept, whereas the negative instance (row 4) lacks the value of attribute F which is in the concept. There were four attributes included in the concept to be formed in each task, and four attributes not included in the concept; thus, the number of attributes included and not included in the concepts were equal for the two tasks.[22]

The tasks possessed several features which helped to control the influence of extraneous variables. 1) The exclusive use of position attributes controlled for possible interactions of attribute type with anxiety and intelligence. Hoffman (1955) found large differences in concept formation proficiency due to intelligence for some types of attributes and no differences for others. Stacey and Markin (1951) found preferences for the use of different attributes at different intelligence levels. Ate (1955) found clinically anxious subjects were better able to use intensity attributes, whereas nonanxious subjects were better able to use qualitative or pattern attributes. 2) Position attributes also permitted a wide variation in the number of attributes employed in the tasks. This flexibility in the tasks permitted variations in the number of attributes employed in the tasks during pilot work which made possible the development of a

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[22] If the tasks had differed in the number of attributes which were not included in the task, there might have been an intelligence by tasks interaction due to this factor. Osler and Trautman (1961) reported that the performance of subjects of bright normal intelligence was sensitive to variations in the number of attributes which were not included in the concept whereas the performance of subjects of normal intelligence was not.

task of appropriate complexity for the intelligence level of the subjects who were to be employed in the main experiment. In previous research, it was sometimes necessary to develop new tasks in order to vary the number of attributes (Hovland, 1953).

The two tasks employed in this study differed somewhat in the way in which deductively certain information about the inclusion of the attributes in the concept was provided, resulting in slight differences in task complexity. The less complex task (Task 2) will be discussed first.

Task 2. In each instance of this task, the value of one attribute was different from its value in the initial positive instance.[23] Information relating each attribute to the concept was given by one particular instance. Each of the four attributes which was not included in the concept was identifiable from information given by a particular positive instance: when the value of an attribute in a positive instance was different from its value in the first positive instance, it could be deduced that the attribute was not included in the concept. The identity of each of the four attributes which was included in the concept was established, in a similar way, by negative instances: since each negative instance differed in the value of only one attribute, compared to the first positive instance, it could be deduced that this attribute was included in the concept. Since there were four

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[23] 23. The sequence of instances used in Task 2 was suggested by Bruner's description (Bruner, Goodnow and Austin, 1956; p. 87) of the sequence which would be ideal if the subject were following a conservative focusing strategy.

attributes which were included in the concept, four negative instances were required to identify them; similarly four positive instances were required to identify the unincluded attributes. In order to provide all the information necessary to form the concept in Task 2, nine instances were required: an initial positive instance, followed by four additional positive instances, and four negative instances.

Task 1. In each instance of this task, the values of two attributes were different from the first positive instance.[24] The information identifying the attributes which were not included in the concept was provided by positive instances in the same way as in Task 2, except that each positive instance identified two attributes which were not included in the concept. However, information identifying the attributes which were included in the concept was provided in a somewhat more complex manner. Each negative instance provided information from which it could be deduced that one or the other of the two attributes which varied was included in the concept. A subsequent positive instance was provided which established that one of these two attributes was not included in the concept, at which point it could be deduced that the other attribute was included. Therefore, both a negative and a positive instance were required to identify each attribute which was included in the concept. An attempt was made to provide this information in the same number of positive and

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[24] The sequence of instances used in this task was suggested by Bruner's description (1956, pp. 89-90) of the sequence of instances which would be ideal if the subject were following a focus gambling strategy.

negative instances as were employed in Task 2. The closest approach to this goal was obtained by the use of four positive instances, the initial instance and three positive instances which established the attributes not included in the concept, plus four negative instances which, aided by the positive instances, established the attributes included in the concept. In order to bring the total number of instances to nine, as in Task 2, an additional negative instance was added which contained no information useful for deducing conclusions about the concept. The greater proportion of negative to positive instances in Task 1 probably contributed slightly to the greater complexity of this task. Besides the information-carrying instances (the first nine), each task contained four additional instances which provided redundant information, thereby raising the total number of instances to thirteen. This prevented the subject from using what would otherwise have been the end of the task as a cue which indicated that all relevant information had been given.

In order to obtain the appropriate level of task complexity necessary to show the expected interaction of anxiety and intelligence, pilot work was done, using various levels of task complexity, to evaluate the performance of subjects drawn from the same population as those in the main experiment. The aim was to develop tasks for which there were minimal floor and ceiling effects, i.e., there were a minimum number of high intelligence subjects who achieved the best possible scores and a minimum number of low intelligence subjects who made the worst possible scores. In the pilot work, the total number of attributes and the proportions of attributes which were and were not

included in the concept were systematically varied. The two tasks previously described were eventually chosen for the experiment. These tasks differed slightly in their intrinsic complexity. Since Task 1, which was given first, was the more complex of the two it was assumed that the differences in complexity between the tasks would be enhanced by practice effects. Pilot work had shown that subjects tended to be more proficient on the second of two concept formation tasks where the tasks were of equal intrinsic complexity. Thus, the tasks were differentiated by a combination of intrinsic complexity and the effects of practice.[25]

Procedure

Prior to the experiment all subjects were given the MAS and the L-scale in a group testing session held in conjunction with their introductory psychology course. Participation in group testing was a course requirement.

The experimental session began with instructions to the subject (see Appendix C) which were designed to induce a mild stress. The subject was told that the experiment "is part of an investigation of factors which affect college grades. We expect that persons who are good at conceptual thinking should be able to do better in college courses which involve abstractions

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[25] Since the difficulty of the tasks for the population of subjects to be used could not be exactly determined, the differences between the tasks were introduced in the hope that at least one task would be of the correct level of difficulty to show the expected anxiety by intelligence interaction.

and generalizations."[26] Since pilot work had shown that the subjects had trouble understanding abstract terms, such as concept, attribute, value, and instance, words were substituted for these terms which related more directly to the actual stimulus materials used: concept became rule, attribute became position, value became symbol, and instance became row. In the instructions: 1) The subject was told that the experiment was concerned with conceptual thinking. 2) Definitions and examples were given for symbols, rows, positions, and rules (the examples are given in Appendix C). 3) The subject was told that only one value of each attribute was involved in the rule. He was not told how many attributes were involved. 4) Positive and negative rows were defined as rows which do and do not conform to the rule respectively, and the subject was given practice at classifying rows in this regard. 5) The subject was told that the task was to discover the rule "by examining the rows and noting whether they conform to the rule or not." 6) The subject was told to report hypotheses about the rule when he was confident that he had discovered the rule.

The first task was presented to the subject with only the first instance in view. The experimenter told the subject whether the instance was positive or negative. After he had inspected the first instance and reported his knowledge of

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[26] Hicks (1961) showed that anxiety affected performance in a serial verbal learning task only when psychological stress was induced.

[illegible]

[illegible]

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[illegible]

attribute inclusion,[27] the second instance was exposed. The instances were presented in turn in this manner. In order to reduce the subject's memory load (Cahill and Hovland, 1960), the previously presented instances were left in view; memory load was further reduced since the instances appeared in the order of their presentation. If the subject reported a rule before the thirteenth instance, he was asked to continue examining the remaining rows in order to check the rule he had derived. When he had completed the thirteenth row, the second task was given in the same way.

After completing the second task, the subject was interviewed to obtain a detailed description of the reasoning which he had used to form the concept. The interview questions are given in Appendix E.

## Measures of concept formation proficiency

The measures used in this study were the subject's correct and erroneous reports of knowledge of attribute inclusion. The subjects made their reports for each attribute after examining an instance by writing I, N, or ? in a box provided on the record sheet (shown in Appendix D). The instructions told the subjects how to record their reports, and provided extensive examples and practice in such recording (the practice record

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27. For the first instance of each problem, if the subject did not report ? for all attributes, he was told that this was the correct report. The reports for the first instance were not included in the measures of concept formation proficiency.

sheet and task record sheet are shown in Appendix D). The subject was required to complete his reports for one instance before the next instance was presented, and was not allowed to change the reports he had recorded for previous instances. However, he could make changes in his reports in the boxes provided for the instance he was currently examining. In order to reduce the subject's memory load (Cahill and Hovland, 1960) written reports were required and these remained open to the subject's inspection. In addition, a key to the symbols used in reporting, I, N, and ?, was provided on the record sheet, and the subjects were allowed to make other notes if they wished.

The measures derived from the subject's reports were obtained primarily from the information-carrying instances (instances 2 through 9).[28] The first instance was excluded because it provided no information about attribute inclusion. Although the subject's reports for instance 10 through 13 were also available, these results are not reported here because the various characteristics of the tasks were matched only for the first nine instances. Also the correctly deducible conclusion /? does not exist after instance nine since the first nine instances provide all the information necessary to form the concept, whereas the last four contain redundant information.

An attempt was made to construct the tasks so that there would be an equal number of each type of correct con-

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[28] The redundant negative instance (number 8) in Task 1 was also scored.

clusion, /I, /N, and /?, both within each task and between the two tasks, for the scored instances. Because of the differences between the tasks, this matching could only be partially achieved:[29] of the total of 48 scored reports for Task 1 there were 16 correct /I's, 16 /N's, and 16 /?'s; of the 64 scored reports for Task 2 there were 16 /I's, 20 /N's, and 28 /?'s. The frequency of the subject's reports in the N and ? categories for the latter task were scaled down to a possible maximum of 16 by multiplying them by .8 and .571429 respectively, in order to provide equal numbers of scored reports for the two tasks.

The subject's reports were scored by comparing them to the deducible reports as described in Chapter II. The correct reports for each task are shown in Appendix B.

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[29] The difference between the tasks causes an additional difficulty. When the subject is presented with a negative instance in Task 1, the correct conclusion for him to draw is that one of the two attributes which are varied is included in the concept. Since the subject does not know, for either attribute, whether it is included or is not included, the correct report of attribute inclusion would be "/?." There are 16 reports of knowledge of attribute inclusion which call for this conclusion. However, since this kind of information is found only in one task, the subject's reports on those 16 occasions were excluded from the analyses.

# Chapter IV

# RESULTS

The results will be presented in two parts. First, the effects of anxiety and intelligence upon the subject's correct reports were evaluated. Then, the effects of anxiety and intelligence upon different types of errors were analysed.[30]

## Analysis of correct reports

A subject's general level of proficiency in concept formation was assessed by the number of correct reports of knowledge of attribute inclusion which he made. A correct report was defined as a conclusion which was deducible from the information given. The total number of correct reports made by a subject was the sum of the three simple types of correct reports, I/I, N/N, and ?/?.

The mean number of correct reports, with standard deviations, for each of the four subject groups on each task is shown

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[30] A summary of all significant findings which were obtained is found in Appendix F.

in Table II. These data were evaluated by an analysis of variance (Lindquist, 1953; Type III) which is summarized in Table III. The interaction of anxiety and intelligence was statistically significant ($P < .05$). This interaction is shown in Figure 1 in which it may be noted that the HiA-HiIQ group made more correct reports than did the LoA-HiIQ group, whereas the HiA-LoIQ group made fewer correct reports than did the LoA-LoIQ group. Thus, as was expected, anxiety facilitated the concept formation of high intelligence subjects and interfered with the concept formation of low intelligence subjects.

The interaction of intelligence and tasks was also statistically significant ($P < .001$). This interaction is shown in Figure 2 where it may be noted that the high intelligence subjects made more correct reports on Task 2 than on Task 1, whereas the low intelligence subjects made about the same number of correct reports on each task. Thus, the high intelligence subjects improved in their performance from Task 1 to Task 2 but the low intelligence subjects did not.

The interactive effects of anxiety and intelligence and the interactive effects of intelligence and tasks upon concept formation proficiency, as found for correct reports, might be more clearly interpreted if the subject's conclusions were examined in more detail. Data were available for the six types of errors made by the subjects in forming their conclusions about the concept.

## Table II

## MEAN NUMBER OF CORRECT REPORTS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS ON BOTH TASKS

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | 35.72 | 44.25 | 30.79 | 42.38 | 38.28 |
| | σ | 7.71 | 5.70 | 7.17 | 6.66 | 8.58 |
| LoIQ | M | 27.22 | 28.38 | 33.07 | 33.55 | 30.55 |
| | σ | 7.54 | 9.47 | 8.25 | 8.48 | 8.69 |
| | M | 31.47 | 36.31 | 31.93 | 37.96 | |
| | σ | 8.64 | 11.14 | 7.67 | 8.71 | |

## Table III

## SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR CORRECT REPORTS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 31.292 | |
| Intelligence (I) | 1 | 1672.015 | 19.442 *** |
| A X I | 1 | 556.001 | 6.465 * |
| Error between | 52 | 85.997 | |
| Within subjects | (56) | | |
| Tasks (T) | 1 | 829.198 | 25.587 *** |
| T X A | 1 | 9.841 | |
| T X I | 1 | 597.744 | 18.444 *** |
| T X A X I | 1 | 25.569 | |
| Error within | 52 | 32.407 | |

***$p < .001$

*$p < .05$

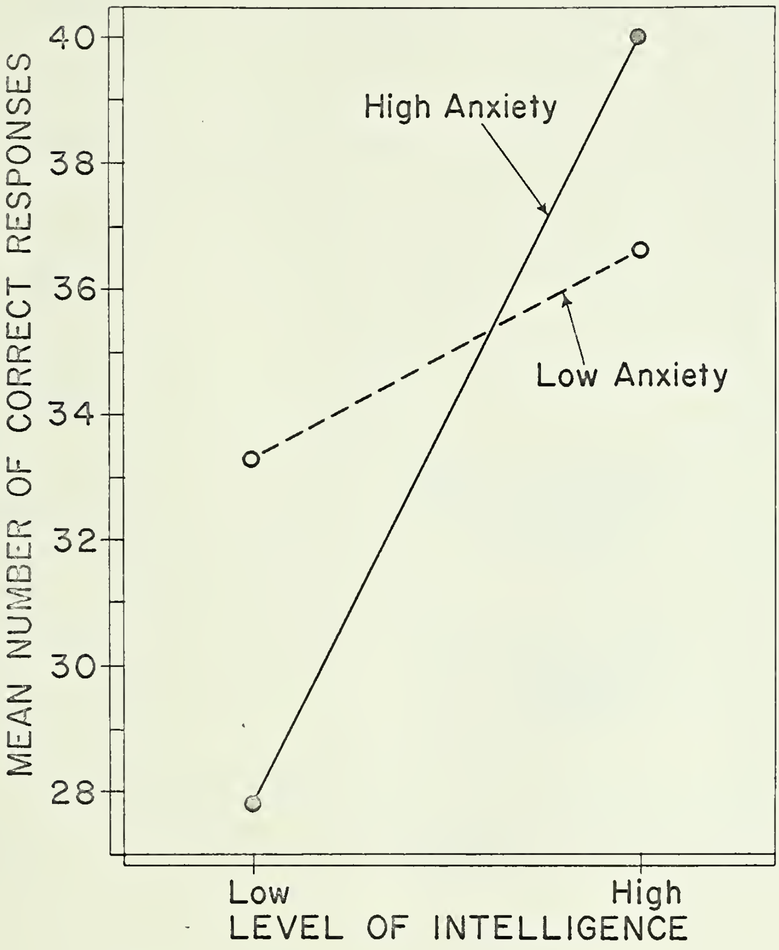

Figure 1

Mean number of correct responses (reports) for the four Experimental Groups, HiA-HiIQ, HiA-LoIQ, LoA-HiIQ, and LoA-LoIQ

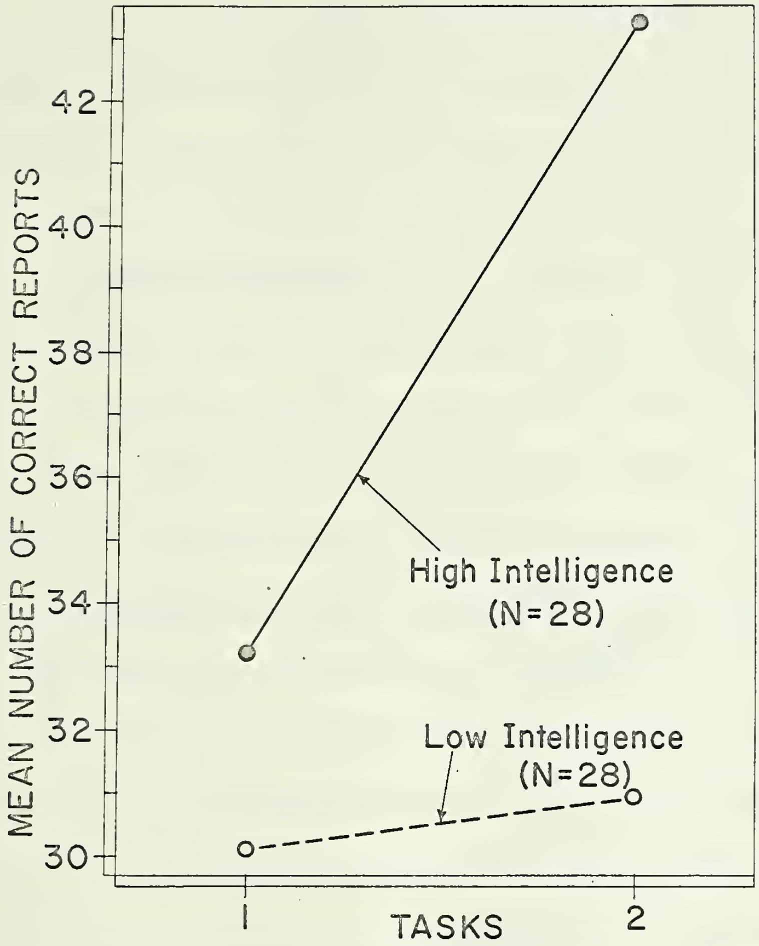

Figure 2

Mean number of correct reports for subjects with high intelligence and for subjects with low intelligence on each of the two concept formation tasks

Analysis of errors in concept formation

The types of errors of reported knowledge of attribute inclusion which were examined were: I/N, N/I, I/?, N/?, ?/I, and ?/N. The data for each error type were analysed by separate analyses of variance (Lindquist, 1953; Type III). Since the results for the error measures will be used to explicate the findings for correct reports, two error types, ?/N and N/?, which were not useful in this regard, will not be considered.[31] The remaining four error types will be presented in terms of the obtained effect for correct reports which they explicate.

The interactive effects of anxiety and intelligence upon errors. A significant interaction of anxiety and intelligence was obtained for only one of the six error types, N/I errors. The mean number of N/I errors, with standard deviations, for each of the four experimental groups is shown in Table IV and the analysis of variance is summarized in Table V.[32] The interaction of anxiety and intelligence was statistically significant ($P < .05$): the HiA-HiIQ group made fewer N/I errors than the LoA-HiIQ group, whereas the HiA-LoIQ group made more N/I errors than the LoA-LoIQ group. Thus, anxiety and intelligence had interactive effects upon the subject's ability to draw a definite conclusion, when he was presented with information establishing that an attribute was included in the concept: anxiety

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[31] The results for ?/N and N/? errors are shown in Appendix G.

[32] The table of means and standard deviations for the four experimental groups on each task is shown in Appendix G.

Table IV

MEAN N/I ERRORS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS, HIA-HIIQ, LOA-HIIQ, HIA-LOIQ, AND LOA-LOIQ

| | | HiA | LoA |
|---|---|---|---|
| HiIQ | M | .35 | 3.82 |
| | σ | .91 | 3.68 |
| LoIQ | M | 1.60 | 1.96 |
| | σ | 4.23 | 3.50 |

Table V

SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR N/I ERRORS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 2.580 | |
| Intelligence (I) | 1 | 102.223 | 8.207 ** |
| A X I | 1 | 67.581 | 5.426 * |
| Error between | 52 | 12.455 | |
| Within subjects | (56) | | |
| Task (T) | 1 | 3.938 | |
| T X A | 1 | 3.937 | |
| T X I | 1 | 27.009 | 2.704 |
| T X A X I | 1 | .223 | |
| Error within | 52 | 9.988 | |

**$p < .01$

*$p < .05$

facilitated this aspect of concept formation for high intelligence subjects, and interfered with it for low intelligence subjects.

A slight trend towards an anxiety by intelligence interaction for I/N errors may be noted in Table VI in which the means and standard deviations for these errors are given. These errors are similar to N/I errors in that both types are commission errors with information given. The HiA-LoIQ group tended to make more I/N errors than the LoA-LoIQ group. The failure to obtain a statistically significant interaction of anxiety and intelligence for I/N errors (the summary of the analysis of variance is shown in Appendix G) appears to be related to a floor effect for the high intelligence groups on this error measure; the mean error scores for the high intelligence groups were less than .25 for each task which is very close to the minimum score of 0 errors.[33]

The effects of intelligence upon errors. The finding of an intelligence by tasks interaction for total correct reports has already provided evidence that the prediction in this experiment, based on the findings in many previous studies, that higher levels of intelligence would tend to facilitate concept formation was possibly based upon an oversimplified analysis of concept formation. Further evidence of this was forthcoming when the error types were examined.

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[33] This floor effect is probably due to the fact that the deducible conclusions for I/N errors and for N/I errors are different. For I/N errors the deducible conclusion is /N, and /N conclusions are established by positive instances. For N/I errors the deducible conclusion is /I, and /I conclusions are established primarily by negative instances. Since negative instances are known to be harder to use than positive instances (Hovland and Weiss, 1953), subjects should make more N/I errors than I/N errors. In the present experiment, the high intelligence subjects made almost no I/N errors.

The expected facilitation of concept formation by intelligence was obtained for only two error types, I/N and I/?.[34] The means and standard deviations for these error measures are given in Table VI. The relevant analyses of variance are summarized in Appendix G. The data for I/N errors show that, on both tasks, both low intelligence groups made more errors than did the high intelligence groups ($F = 7.121$; $df = 1/52$; $P < .05$). The data for I/? errors show that, on both tasks, both low intelligence groups made many more errors than did the high intelligence groups ($F = 19.427$; $df = 1/52$; $P < .001$). These results indicate a tendency on the part of low intelligence subjects to erroneously conclude that an attribute is included in the concept, especially when no deductively useful information has been given.

An intelligence by tasks interaction, which paralleled the interaction of these variables for correct reports, was found for only one error type, ?/I errors. The mean number of ?/I errors, with standard deviations, on each task for the four experimental groups is given in Table VII and the analysis of variance is summarized in Table VIII. The significant interaction of intelligence and tasks ($P < .001$), is depicted in Figure 3. The high intelligence subjects made more ?/I errors than the low intelligence subjects on Task 1, whereas, on Task 2, the high intelligence subjects made somewhat fewer errors than the low

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[34] A significant main effect of intelligence was obtained for N/I errors, but the effect was a by-product of the interaction of anxiety and intelligence.

## Table VI

## MEAN NUMBER OF I/N AND I/? ERRORS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS ON BOTH TASKS

**I/N Errors**

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | .21 | .06 | .21 | .00 | .12 |
| | σ | .58 | .21 | .42 | .00 | .38 |
| LoIQ | M | 2.78 | 1.54 | 1.07 | 1.20 | 1.65 |
| | σ | 3.60 | 3.77 | 2.05 | 3.24 | 3.22 |

---

**I/? Errors**

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | .93 | 1.18 | .57 | .24 | .73 |
| | σ | 1.86 | 3.20 | 1.45 | .54 | 1.98 |
| LoIQ | M | 6.21 | 6.61 | 4.43 | 5.59 | 5.71 |
| | σ | 6.68 | 6.95 | 5.21 | 7.38 | 6.48 |

Table VII

MEAN NUMBER OF ?/I ERRORS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS ON BOTH TASKS

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | 7.07 | 1.78 | 8.93 | 4.14 | 5.48 |
| | σ | 5.98 | 4.44 | 5.81 | 5.64 | 6.02 |
| LoIQ | M | 3.57 | 4.36 | 4.36 | 4.28 | 4.14 |
| | σ | 5.24 | 6.03 | 4.85 | 6.30 | 5.49 |
| | M | 5.32 | 3.07 | 6.64 | 4.21 | |
| | σ | 5.80 | 5.36 | 5.74 | 5.87 | |

## Table VIII

## SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR ?/I ERRORS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 45.509 | |
| Intelligence (I) | 1 | 50.223 | |
| A X I | 1 | 21.438 | |
| Error between | 52 | 47.757 | |
| Within subjects | (56) | | |
| Tasks (T) | 1 | 153.223 | 10.720 ** |
| T X A | 1 | .223 | |
| T X I | 1 | 203.581 | 14.243 *** |
| T X A X I | 1 | 3.223 | |
| Error within | 52 | 14.293 | |

***$P < .001$

**$P < .01$

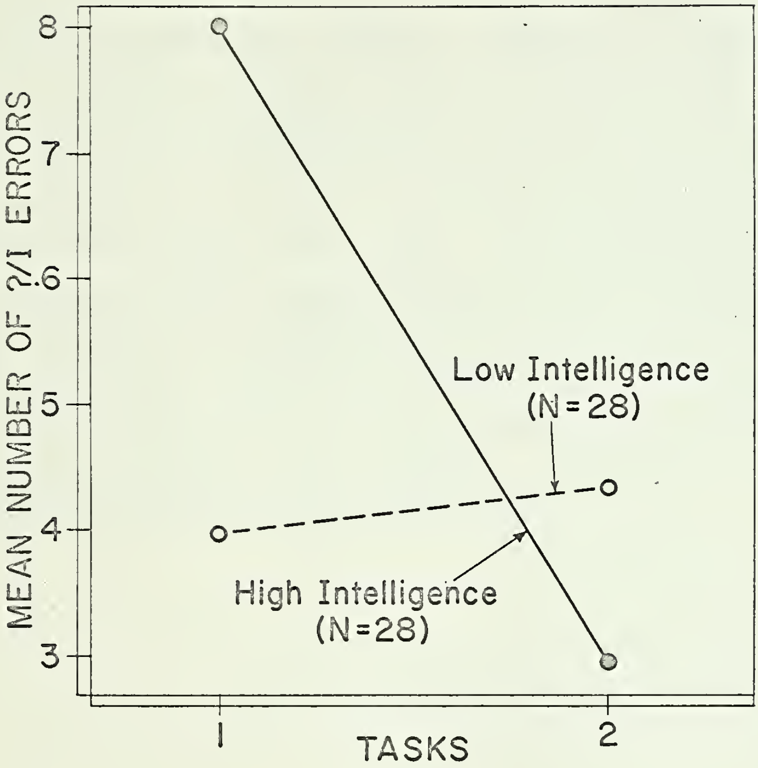

Figure 3

Mean number of ?/I errors for subjects with high intelligence and for subjects with low intelligence on each of the two concept formation tasks

intelligence subjects. This was a rather surprising result: higher levels of intelligence lead to more ?/I errors for the first of two concept formation tasks. However, a similar finding was obtained in a previous study which was part of the pilot work for the present study.[35] It may be concluded that for the more difficult concept formation task, high intelligence subjects, when faced with information establishing that an attribute was included in the concept, tended to report that they did not know whether or not the attribute was included in the concept more frequently than low intelligence subjects.

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35. In the previous study, using somewhat difference concept formation tasks, high intelligence subjects made more ?/I errors for the first three of four tasks.

## Chapter V

## DISCUSSION

### The Effects of Anxiety and Intelligence on Concept Formation

The results for total correct reports of knowledge of attribute inclusion showed that anxiety facilitated concept formation proficiency for higher levels of intelligence and interfered with concept formation proficiency for lower levels of intelligence (Figure 1, p. 43). This finding was consistent with the expectation derived from the extension of Spence's (1958) theory to include intelligence as a variable. The obtained interaction was interpreted within the extended theory according to the following line of reasoning:

1) Since task difficulty was assumed to be a function of intelligence and task complexity, and since task complexity was held relatively constant, it was assumed that differences in task difficulty would be produced by the differences in intelligence among the subjects, i.e., high intelligence subjects would find the tasks easier than did low intelligence subjects. The results were consistent with this assumption since high intelligence subjects drew more correct conclusions about the concepts (Figure 2, p. 44), and therefore fewer incorrect conclusions, than did low intelligence subjects.

2) Previous studies have shown that higher levels of anxiety facilitated performance on tasks which were assumed to elicit few incorrect response tendencies, and impaired performance on tasks which were assumed to elicit many incorrect response tendencies. Since, according to 1), for a given task, high intelligence subjects should show fewer incorrect response tendencies than low intelligence subjects, it was expected that higher levels of anxiety would facilitate the concept formation proficiency of high intelligence subjects and impair the concept formation proficiency of low intelligence subjects. This expectation was confirmed by the results.

The interaction of anxiety and intelligence for correct reports was further explicated by examining the six error types. If a finding obtained for correct reports was also obtained for one or more error types it could be said that the finding for the error types had determined the finding for correct reports. This was so because the six error types added together produced total errors, which was the complement of total correct reports.

The anxiety by intelligence interaction for correct reports was found to be determined by similar interactions of these variables for the two simple error types, N/I and I/N, which fall into the category of commission errors with information given. For this category of errors, anxiety facilitated the performance of high intelligence subjects and impaired the performance of low intelligence subjects. The obtained interaction was statistically significant for N/I errors; for I/N errors, although similar trends in the means were observed, the relationship appeared to have been obscured by a floor effect in both high intelligence groups. The finding of an anxiety by intelligence interaction

solely for errors categorized as commission errors with information given is consistent with the theoretical notions from which the interaction was predicted. A commission error with information given is analogous to an erroneous response to a stimulus in Spence's theory of anxiety and performance. Therefore, errors of this type would be expected to show the anxiety by intelligence interaction predicted by the theory. On the other hand both omission errors and errors made with no information given have no obvious counterparts in the theory. A similar approach to the isolation of the effects of anxiety and intelligence upon various types of errors has been taken by Spielberger and Grier[36] in a study of serial verbal learning. The present writer combined certain of these authors' error types into the categories, commission errors[37] and omission errors, and found that the effects of intelligence and anxiety tended to interact for commission errors but not for omission errors; for commission errors anxiety facilitated the performance of the brighter subjects and interfered with the performance of the duller subjects, as was the case for commission errors with information given in the present study.

## The Effects of Intelligence on Concept Formation

Previous studies have reported that higher levels of intelligence facilitated concept formation. In the present experiment, similar findings were obtained for correct reports: the

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[36] Personal communication, June 15, 1961.

[37] Commission errors in a serial verbal learning procedure are analogous to commission errors _with information given_ in concept formation since a member of the list to be learned is present as a stimulus on each trial.

high intelligence subjects made more correct reports on both tasks than did low intelligence subjects (Figure 2, p. 44). However, the results were more complicated than is suggested by this finding. For correct reports, the effects of intelligence interacted with the effects of the tasks so that the facilitation of concept formation by intelligence was much more marked on the second task. These findings for correct reports were further explicated by examining the results for the error types.

The general facilitation of concept formation by intelligence, shown in correct reports, was found for three of the six error types, N/I, I/N, and I/?. For N/I errors and I/N errors the effects of intelligence were complicated by those of anxiety; the interactive effects of anxiety and intelligence for these error types have already been discussed. For I/? errors, the effects of intelligence were independent of those of anxiety: low intelligence subjects made many more I/? errors than high intelligence subjects. This finding indicates that low intelligence subjects tended to conclude that an attribute was included in the concept (I) when insufficient information had been given for deducing whether or not the attribute was included (/?). This type of error was the strongest single erroneous tendency on the part of low intelligence subjects, constituting about one-third of their total errors.

Examination of the interviews given to the subjects upon completion of the concept formation tasks suggested an explanation for the tendency of low intelligence subjects to make I/? errors. These subjects appeared to use a relatively simple strategy[38] in

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[38] A strategy is a method of translating information given into conclusions about the concept, e.g., the use of cognitive principles described in the hypothetical examples in Chapter II. Bruner, Goodnow and Austin (1956, p. 54) have used the term in a somewhat similar sense.

forming their concepts, presumably because their relatively limited intellectual capacity made the tasks difficult for them. Their strategy was not only simple but focused upon discovering the attributes which were included in the concept rather than those which were not included in the concept, possibly because the instructions stressed this aspect of the task. The strategy which low intelligence subjects appeared to prefer was an inductive one: they tended to conclude that an attribute was included in the concept if its value had remained the same in two or three positive instances. This strategy lead to I/? errors because, in the tasks employed, the erroneous report that an attribute was included in the concept could often be made on an inductive basis before a correct report that the attribute was included could be made on the deductive basis used to define correct reports.

Perhaps the most surprising complication of the effects of intelligence upon concept formation, found in the present study, was the interaction of intelligence and tasks for ?/I errors: high intelligence subjects made more ?/I errors on the first task than low intelligence subjects, whereas high intelligence subjects made slightly fewer ?/I errors on the second task than low intelligence subjects (Figure 3). Thus, on the first of two concept formation tasks, brighter subjects tended more frequently than duller subjects to report that they did not know whether or not an attribute was included in the concept (?), when they could have deduced that it was included (/I). This was the strongest erroneous tendency among high intelligence subjects; more than half of their total errors were ?/I errors.

Examination of the interviews suggested an explanation for the finding that high intelligence subjects made more ?/I errors

on the first task. High intelligence subjects appeared to use deductive strategies, e.g., if only one attribute had a different value in a negative instance compared to a positive instance they concluded that that attribute was included in the concept (see page 5, and pages 31-32 for other deductive strategies). Such strategies led to ?/I errors because the information which established the deducible conclusion /I was conveyed primarily by negative instances which are known to be relatively difficult to use in concept formation (Hovland and Weiss, 1953). Deductive strategies may have led to more ?/I errors on the first task than on the second task because the information from which the conclusion /I could be deduced was more complex in the first task: in Task 1 this information was conveyed by combinations of negative and positive instances, whereas in Task 2 it was conveyed by negative instances only (see page 31-32). When faced with these particularly difficult kinds of information, which had to be used in a successful deductive strategy, high intelligence subjects may have been reluctant to draw the deducible conclusion /I until they were quite certain that it was correct; therefore, they may have reported that they did not know (/?) instead. In contrast to this, low intelligence subjects encountered these difficult kinds of information less often because they tended to use positive rather than negative instances to induce the attributes included in the concept (I).

# APPENDIXES

# Appendix A

## Taylor Manifest Anxiety Scale

## BIOGRAPHICAL QUESTIONNAIRE

Do not write or mark on this booklet in any way. Your answers to the statements in this inventory are to be recorded *only* on the separate Answer sheet.

Print your name on the blank provided on the Answer sheet.

The statements in this booklet represent experiences, ways of doing things or beliefs or preferences that are true of some people but are not true of others. You are to read each statement and decide whether or not it is true with respect to yourself. If it is *true* or *mostly true*, put an *x* in the space under the letter *a* on the Answer sheet next to the same number as the statement you are answering. If the statement is *not usually true* or is *not true* at all, put an *x* in the space under the letter *b*. You must answer the statement as carefully and honestly as you can. There are no correct or wrong answers: we are interested in the way *you* work and in the things *you* believe.

Remember: Mark the answer space in column *a* if the statement is true or mostly true; mark the answer space in column *b* in the Answer sheet if the statement is false or mostly false. Mark each item as you come to it. Here is an example:

| | a | b |
|---|---|---|
| I would like to be a farmer. | ☐ | ☐ |

If you would like to be a farmer, that is, if the statement is true as far as you are concerned, you would mark in the space under the letter a. If the statement is false, you would mark in the space under the letter b.

DO NOT MARK ON THIS BOOKLET

**NOTE:** The 15 L-scale items from the Minnesota Multiphasic Personality Inventory are indicated by an (L) after the item.

1. I am often sick to my stomach.

2. I do not tire quickly.

3. I am no more nervous than other people.

4. I have very few headaches.

5. I work under a great deal of strain.

6. Once in a while I think of things too bad to talk about. (L)

7. I cannot keep my mind on one thing.

8. I worry over money and business.

9. I frequently notice my hand shakes when I try to do something.

10. I blush no more often than others.

11. I do not always tell the truth. (L)

12. I have diarrhea ("the runs") once a month or more.

13. I worry quite a bit over possible troubles.

14. I practically never blush.

15. I get angry sometimes. (L)

16. I am not often afraid that I am going to blush.

17. I have nightmares every few nights.

18. My hands and feet are usually warm enough.

19. I sweat very easily even on cool days.

20. When embarrassed I often break out in a sweat which is very annoying.

21. Sometimes when I am not feeling well I am cross. (L)

22. I do not often notice my heart pounding and I am seldom short of breath.

23. I feel hungry almost all the time.

24. If I could get into a movie without paying and be sure I was not seen, I would probably do it. (L)

25. Often my bowels don't move for several days at a time.

26. I have a great deal of stomach trouble.

27. I would rather win than lose in a game. (L)

28. At times I lose sleep over worry.

29. My sleep is restless and disturbed.

30. I often dream about things I don't like to tell other people.

31. I like to know some important people because it makes me feel important. (L)

32. I am easily embarrassed.

33. My feelings are hurt easier than most people.

34. I often find myself worrying about something.

35. I do not like everyone I know. (L)

36. I wish I could be as happy as others.

37. I am usually calm and not easily upset.

8. I gossip a little at times. (L)

9. I cry easily.

0. I feel anxious about something or someone almost all the time.

1. I am happy most of the time.

2. It makes me nervous to have to wait.

3. Sometimes at elections I vote for men about whom I know very little. (L)

4. At times I am so restless that I cannot sit in a chair for very long.

45. Sometimes I get so excited that I find it hard to get to sleep.

46. I have often felt that I faced so many difficulties I could not overcome them.

47. Once in a while I laugh at a dirty joke. (L)

48. At times I have been worried beyond reason about something that really did not matter.

49. I do not have as many fears as my friends.

50. I have been afraid of things or people that I know could not hurt me.

51. At times I feel like swearing. (L)

52. I certainly feel useless at times.

53. I find it hard to keep my mind on a task or job.

54. I am more self-conscious than most people.

55. I do not read every editorial in the newspaper every day. (L)

56. I am the kind of person who takes things hard.

57. I am a very nervous person.

58. Life is often a strain for me.

59. At times I think I am no good at all.

60. Once in a while I put off until tomorrow what I should do today. (L)

61. I am not at all confident of myself.

62. At times I feel that I am going to crack up.

63. I don't like to face a difficulty or make an important decision.

64. My table manners are not quite as good at home as when I am out in company. (L)

65. I am very confident of myself.

## Appendix B

### Figure 4

line /
star *
colon :

|  | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 + | / | / | * | / | : | * | * | : |
| 2 - | / | / | * | : | * | * | * | : |
| 3 - | / | : | * | / | : | * | : | : |
| 4 + | / | / | * | : | : | * | / | : |
| 5 - | * | / | * | / | : | * | * | * |
| 6 - | / | / | / | / | : | : | * | : |
| 7 + | / | / | : | / | : | * | / | : |
| 8 - | / | / | * | / | : | : | * | / |
| 9 + | * | / | * | * | : | * | * | : |
| 10 - | / | / | * | : | : | * | * | * |
| 11 - | : | / | * | / | : | / | * | : |
| 12 - | / | * | * | / | * | * | * | : |
| 13 + | : | / | * | * | : | * | * | : |

Task 1

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| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

Figure 5

line /
star *
colon :

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 + | / | * | / | : | / | : | * | * |
| 2 + | / | / | / | : | / | : | * | * |
| 3 + | / | * | / | : | : | : | * | * |
| 4 - | / | * | / | : | / | / | * | * |
| 5 - | / | * | / | * | / | : | * | * |
| 6 - | / | * | : | : | / | : | * | * |
| 7 + | / | * | / | : | / | : | * | / |
| 8 + | / | * | / | : | / | : | : | * |
| 9 - | * | * | / | : | / | : | * | * |
| 10 + | / | : | / | : | / | : | * | * |
| 11 - | : | * | / | : | / | : | * | * |
| 12 + | / | * | / | : | / | : | * | : |
| 13 - | / | * | * | : | / | : | * | * |

Task 2

Appendix B

Figure 6

**Task 1**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | A | $\underline{B}$ | C | D | $\underline{E}$ | $\underline{F}$ | G | $\underline{H}$ |  |  |  |  |  |  |  |  |  |  |  | A | $\underline{B}$ | C | D | $\underline{E}$ | $\underline{F}$ | G | $\underline{H}$ |
| 1 | + | / | / | * | / | : | * | * | : |  |  |  |  |  |  |  |  |  | 1 | + | ? | ? | ? | ? | ? | ? | ? | ? |
| 2 | - | / | / | * | $\boxed{:}$ | $\boxed{*}$ | * | * | : | D∨E |  |  |  |  |  |  |  |  | 2 | - | ? | ? | ? | O | O | ? | ? | ? |
| 3 | - | / | $\boxed{:}$ | * | / | : | * | $\boxed{:}$ | : | B∨G |  |  |  |  |  |  |  |  | 3 | - | ? | O | ? | O | O | ? | O | ? |
| 4 | + | / | / | * | $\boxed{:}$ | : | * | $\boxed{/}$ | : | ~D ~G, ∴E, ∴B |  |  |  |  |  |  |  |  | 4 | + | ? | I | ? | N | I | ? | N | ? |
| 5 | - | $\boxed{*}$ | / | * | / | : | * | * | $\boxed{*}$ | A∨H |  |  |  |  |  |  |  |  | 5 | - | O | I | ? | N | I | ? | N | O |
| 6 | - | / | / | $\boxed{/}$ | / | : | $\boxed{:}$ | * | : | C∨F |  |  |  |  |  |  |  |  | 6 | - | O | I | O | N | I | O | N | O |
| 7 | + | / | / | $\boxed{:}$ | / | : | * | $\boxed{/}$ | : | ~C( ~G), ∴F |  |  |  |  |  |  |  |  | 7 | + | O | I | N | N | I | I | N | O |
| 8 | - | / | / | * | / | : | $\boxed{:}$ | * | $\boxed{/}$ |  |  |  |  |  |  |  | F∨H | R | 8 | - | O | I | N | N | I | I | N | O |
| 9 | + | $\boxed{*}$ | / | * | $\boxed{*}$ | : | * | * | : | ~A( ~D), ∴H |  |  |  |  |  |  |  |  | 9 | + | N | I | N | N | I | I | N | I |
| 10 | - | / | / | * | $\boxed{:}$ | : | * | * | $\boxed{*}$ |  |  |  |  |  |  |  | D∨H | R | 10 | - | N | I | N | N | I | I | N | I |
| 11 | - | $\boxed{:}$ | / | * | / | : | $\boxed{/}$ | * | : |  |  |  |  |  |  |  | A∨F | R | 11 | - | N | I | N | N | I | I | N | I |
| 12 | - | / | $\boxed{*}$ | * | / | $\boxed{*}$ | * | * | : |  |  |  |  |  |  |  | B∨E | R | 12 | - | N | I | N | N | I | I | N | I |
| 13 | + | $\boxed{:}$ | / | * | $\boxed{*}$ | : | * | * | : |  |  |  |  |  |  |  | ~A, ~D, ∴F, ∴H | R | 13 | + | N | I | N | N | I | I | N | I |

Concept - B(/) E(:) F(*) H(:)

Key

| Column |  |
|---|---|
| 1 | Instance no. |
| 2 | Positive or negative instance |
| 3-10 | The instances. The two attributes in each instance with values different from those in the first positive instance are shown in boxes. The attributes (lettered positions) in the concepts are underlined. |
| 11-18 | Conclusions deducible from information provided by each instance, e.g., D∨E means D or E or both are included, ~D means D is not included, and ∴E means therefore E is included. Conclusions with left hand margin in Column 11 are not redundant; those with right hand margin in Column 18 and those in brackets are redundant. All non-redundant conclusions are established by the instances above the horizontal line. |
| 19 | R indicates an instance providing redundant information. |
| 20-21 | Instance no., and positive or negative instance. |
| 22-29 | Correct reports of knowledge of attribute inclusion deducible from information given. For I, N & ? see page 21; O means or (see footnote 29, page 38). |

Appendix B

Figure 7

Task 2

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\underline{A}$ | B | $\underline{C}$ | $\underline{D}$ | E | $\underline{F}$ | G | H | | | | | | | | | | | | $\underline{A}$ | B | $\underline{C}$ | $\underline{D}$ | E | $\underline{F}$ | G | H |
| 1 | + | / | * | / | : | / | : | * | * | | | | | | | | | | 1 | + | ? | ? | ? | ? | ? | ? | ? | ? |
| 2 | + | / | $\boxed{/}$ | / | : | / | : | * | * | ~B | | | | | | | | | 2 | + | ? | N | ? | ? | ? | ? | ? | ? |
| 3 | + | / | * | / | : | $\boxed{:}$ | : | * | * | ~E | | | | | | | | | 3 | + | ? | N | ? | ? | N | ? | ? | ? |
| 4 | - | / | * | / | : | / | $\boxed{/}$ | * | * | F | | | | | | | | | 4 | - | ? | N | ? | ? | N | I | ? | ? |
| 5 | - | / | * | / | $\boxed{*}$ | / | : | * | * | D | | | | | | | | | 5 | - | ? | N | ? | I | N | I | ? | ? |
| 6 | - | / | * | $\boxed{:}$ | : | / | : | * | * | C | | | | | | | | | 6 | - | ? | N | I | I | N | I | ? | ? |
| 7 | + | / | * | / | : | / | : | * | $\boxed{/}$ | ~H | | | | | | | | | 7 | + | ? | N | I | I | N | I | ? | N |
| 8 | + | / | * | / | : | / | : | $\boxed{:}$ | * | ~G | | | | | | | | | 8 | + | ? | N | I | I | N | I | N | N |
| 9 | - | $\boxed{*}$ | * | / | : | / | : | * | * | A | | | | | | | | | 9 | - | I | N | I | I | N | I | N | N |
| 10 | + | / | $\boxed{:}$ | / | : | / | : | * | * | | | | | | | ~B | | R | 10 | + | I | N | I | I | N | I | N | N |
| 11 | - | $\boxed{:}$ | * | / | : | / | : | * | * | | | | | | | A | | R | 11 | - | I | N | I | I | N | I | N | N |
| 12 | + | / | * | / | : | / | : | * | $\boxed{:}$ | | | | | | | ~H | | R | 12 | + | I | N | I | I | N | I | N | N |
| 13 | - | / | * | $\boxed{*}$ | : | / | : | * | * | | | | | | | C | | R | 13 | - | I | N | I | I | N | I | N | N |

Concept - A(/) C(/) D(:) F(:)

Key

| Column | |
|---|---|
| 1 | Instance no. |
| 2 | Positive or negative instance |
| 3-10 | The instances. The attribute in each instance whose value differs from that in the first positive instance is shown in a box. The attributes (lettered positions) in the concept are underlined. |
| 11-18 | Conclusions deducible from information provided by each instance, e.g., ~B means B is not included, and F means F is included. Conclusions in Cols. 11 & 12 are not redundant; those in Cols. 17 & 18 are redundant. All nonredundant conclusions are established by instances above the horizontal line. |
| 19 | R indicates an instance providing redundant information. |
| 20-21 | Instance no., and positive or negative instance. |
| 22-29 | Correct reports of knowledge of attribute inclusion deducible from information given. For I, N, & ? see page 21. |

# Appendix C

## Instructions

Let me begin by reading the instructions.

Set

This is an experiment in conceptual thinking. Conceptual thinking is concerned with the use of abstract ideas, and rules, and general principles. This is part of an investigation of factors which affect college grades. We expect that persons who are good at conceptual thinking should be able to do better in college courses which involve abstractions and generalizations.

Introduction

In this particular experiment the type of abstraction that we will use is in the form of a rule. You will be shown a row of symbols which conform to a simple rule.

Rows and Symbols

For instance, here is such a row of symbols (show sample with first row uncovered). The row is made up of these three symbols only (point to symbols by name). Each position in the row is identified by a letter. Each lettered position can have one and only one of these symbols. (Cover sample.)

Rule

Here is an example of the sort of rule which you will use. The rule might be B-ditto and D-dash. Notice that the rule specifies just one symbol for each position involved in the rule, (say slowly:) B-ditto and D-dash. This row conforms to that rule because it has a ditto at B (point) and it has a dash at D (point). Suppose the rule were A-comma, E-comma, and F-ditto. This row (point) would *not* conform to that rule because, while A has a comma (point), and F has a ditto (point), E does not have a comma (point). Suppose the rule were C-dash; would this row conform to the rule or not? (Ask about row 2). Suppose the rule were F-ditto and G-dash; which of these rows would *not* conform to that rule, F-ditto and G-dash?

**No. of Positions in the Rule**

You can see that the rule can involve one or two or three or more of the positions in the row.

**S Makes Up a Rule**

Please make up a rule yourself and tell me which of these rows conform to it. (Cover sample.)

**Task**

In the tasks which I will give you, your aim will be to discover a rule, which I have in mind, by examining a number of rows of symbols like these. I will show you the rows one at a time, and each time I show you a new row I'll tell you whether it conforms to the rule or not. You can discover the rule by examining the rows, and noting whether they conform to the rule or not. The rule will stay the same throughout the task.

**Reporting Hypotheses**

As soon as you think you have discovered the rule tell me what you think it is. When you are confident that you have discovered the rule you may stop. I won't tell you whether you have the right rule or not.

**Reporting Attribute Status: Example**

We need a record of your progress as you work. Please use this record sheet to record what you discover about the rule (give S his sheet). Here is an example of how you can do this (show example sheet). Suppose the rule is B-ditto and D-dash (point to rule), and suppose you have *discovered* this rule. You can record what you have discovered by putting an I at position B and an I at position D (point to example 1) to indicate that you know they are *involved* in the rule. (Point to I code) I stands for involved in the rule. Then you would put an N for all the other positions (point to N positions) to show that you know they are *not involved* in the rule. (Point to N code) N stands for not involved in the rule. By doing this, (point to row) then, you will have recorded that you know that B and D are involved in the rule, and you know that the other positions are not involved. Is this clear so far?

Suppose you don't know what the rule is. Then you would put a ? for each position to indicate that you don't know whether the position is involved in the rule or not (point to example 2). (Point to ? code) ? stands for don't know.

Now suppose you have discovered something about the rule but not all about it. For instance, you might know that position B is involved in the rule, so you would put an I for B (point to example 3). And you might know that positions E and F are not involved in the rule, so you would put N's for E and F (point). But you might not know whether the other positions are involved in the rule or not so you would put a ? for each of them (point).

Suppose you have discovered that D is involved in the rule and A, C, and G are not involved. What would you put down to record this? Write it out here (point to blank row). If D is involved in the rule and A, C, and G are not involved. (Give B & D involved and H not involved as additional example if needed).

Reporting Attribute Status: In Task

In the task that I will give you, you will be working to discover the rule by examining the rows and noting whether they conform to the rule or not. After you have examined each row, fill in your record sheet in the same way as you did here (point to example), putting an I or an N or a ? for each position. The aim is to record your best knowledge about the rule, which you have obtained from all the rows up to the one you are working on. Remember you can stop when you are confident that you have discovered the rule.

Do you have any questions about what I have read?

Present Task

Alright, here is the first task. (Show whole sheet from a distance, then place before S and cover except for first row, while saying--) These rows are made up of these three symbols only (indicate by name). There is a rule for you to discover and this row conforms to it. The plus (point) indicates that this row conforms to the rule. As soon as you have finished examining each row fill in the record sheet and I will move the card down to show you the next row.

(Indicate that the first line will be all ? if S does not do this)

(Indicate minus for first negative row)

after S stops: Please look at the rest of the rows, one at a time, to see if they add anything to what you know about the rule. (If not, fill in the same)

Obtain guess at row 13.

## Appendix C

Figure 8

ditto "
dash -
comma ,

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | , | " | - | - | " | " | " | - |
| 2 | - | - | , | - | " | - | " | " |
| 3 | " | - | - | , | - | " | - | " |
| 4 | , | , | " | - | " | " | - | - |

Problem practice example

# Appendix D

## Figure 9

I involved in rule
N not involved in rule
? don't know

Rule is B" and D-

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| N | I | N | I | N | N | N | N |

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| ? | ? | ? | ? | ? | ? | ? | ? |

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| ? | I | ? | ? | N | N | ? | ? |

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |

Report Sheet Example

Figure 10

I involved in the rule
N not involved in the rule
? don't know

| | A | B | C | D | E | F | G | H | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | | | | | | | | | |
| 25 | | | | | | | | | |

Report Sheet

# Appendix E

## INTERVIEW

(E may supply vocabulary such as row, position, symbol, and rule if S lacks it)

1) How did you go about figuring out what the rule was?
   (ask about first and second task differences and differences within the tasks)
2) What did the positive rows tell you?
3) What did the negative rows tell you?
   (ask about first negative on each task)
4) How were you able to make use of the first row?
5) How did you use the three response categories, I, N, & ??
   a) What did you mean when you put an I?
   b) (same for N)
   c) (same for ?)
   d) Did you always put ? unless you were very sure it was I or N, or would you tend to put I or N even though you weren't quite sure?
   e) Did this change as you went through the tasks?
6) How hard would you say you tried to do these tasks? How involved did you get in them?
   (a lot, moderately, not much)

7) Which of the tasks was harder?
   - a) Why?
   - b) Do you think you got better at doing this as you went along?

8) Which kind of row gave you the most information? (Positive, negative, or equal)

9) (Ask about the reasoning from positive rows to previous negative rows on the complex task (Task 1))
   - a) (Ask about reporting I because symbols remain the same in positive rows)

10) Is there any special experience that you've had that helped you do this task?
   - a) major subject studied in college?
   - b) math or logic courses?

11) What previous experiments have you been in? (Check for deception experiments)

## Appendix F

## Table IX

Summary of obtained effects significant at $P < .05$ or better

| Measure | Obtained Effects | | | |
|---|---|---|---|---|
| Total Correct | IQ< | Task< | AXIQ | Task x IQ |
| Commission Errors $\bar{c}$ Information Given | | | | |
| N in I Errors | IQ< | ← | AXIQ | |
| I in N Errors | IQ< | | | |
| Commission Errors $\bar{c}$ No Information Given | | | | |
| I in ? Errors | IQ< | | | |
| N in ? Errors | | Task< | | |
| Omission Errors | | | | |
| ? in I Errors | | Task< | ← | Task x IQ |
| ? in N Errors | | Task< | | |

Key: < and > indicate decreasing and increasing errors respectively as the independent variable increases.

← indicates that the effect pointed to is a by-product of the one pointed from.

# Appendix G

# STATISTICAL ANALYSIS OF DATA FOR THE SIX ERROR TYPES

## Table X

## MEAN NUMBER OF N/I ERRORS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS ON BOTH TASKS

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | .43 | .28 | 2.14 | 1.07 | .97 |
| | σ | .76 | 1.07 | 3.37 | 4.01 | 2.73 |
| LoIQ | M | 3.00 | 4.64 | 1.43 | 2.50 | 2.89 |
| | σ | 3.01 | 5.17 | 2.38 | 4.38 | 3.96 |
| | M | 1.71 | 2.46 | 1.78 | 1.78 | |
| | σ | 2.52 | 4.28 | 2.88 | 4.18 | |

## Table XI

## SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR I/N ERRORS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 7.823 | |
| Intelligence (I) | 1 | 65.423 | 7.121 * |
| A X I | 1 | 7.000 | |
| Error between | 52 | 9.187 | |
| Within subjects | (56) | | |
| Tasks (T) | 1 | 3.863 | 2.699 |
| T X A | 1 | 3.023 | 2.122 |
| T X I | 1 | .966 | |
| T X A X I | 1 | 3.571 | 2.495 |
| Error within | 52 | 1.431 | |

*$P < .05$

## Table XII

## SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR I/? ERRORS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 29.448 | |
| Intelligence (I) | 1 | 694.297 | 19.427 *** |
| A X I | 1 | 3.991 | |
| Error between | 52 | 35.737 | |
| Within subjects | (56) | | |
| Tasks (T) | 1 | 3.884 | |
| T X A | 1 | .058 | |
| T X I | 1 | 4.664 | |
| T X A X I | 1 | 3.175 | |
| Error within | 52 | 11.908 | |

***$p < .001$

## Table XIII

## MEAN NUMBER OF ?/N ERRORS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS ON BOTH TASKS

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | 1.28 | .11 | 2.28 | .00 | .91 |
| | σ | 3.47 | .29 | 2.97 | .00 | 2.42 |
| LoIQ | M | 1.07 | .63 | 2.14 | .34 | 1.04 |
| | σ | 1.21 | .50 | 3.03 | .68 | 1.78 |
| | M | 1.17 | .37 | 2.21 | .17 | |
| | σ | 2.55 | .48 | 2.95 | .50 | |

## Table XIV

## SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR ?/N ERRORS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 4.889 | |
| Intelligence (I) | 1 | .438 | |
| A X I | 1 | .017 | |
| Error between | 52 | 4.807 | |
| Within subjects | (56) | | |
| Tasks (T) | 1 | 56.858 | 16.176 *** |
| T X A | 1 | 10.689 | 3.035 |
| T X I | 1 | 2.580 | |
| T X A X I | 1 | .103 | |
| Error within | 52 | 3.521 | |

***$p < .001$

## Table XV

## MEAN NUMBER OF N/? ERRORS, WITH STANDARD DEVIATIONS, FOR THE FOUR SUBJECT GROUPS ON BOTH TASKS

| | | HiA | | LoA | | |
|---|---|---|---|---|---|---|
| | Task | 1 | 2 | 1 | 2 | |
| HiIQ | M | 2.36 | .33 | 3.07 | .16 | 1.47 |
| | σ | 3.34 | 1.22 | 4.51 | .61 | 3.08 |
| LoIQ | M | 4.14 | 1.84 | 1.50 | .53 | 2.00 |
| | σ | 5.79 | 3.33 | 3.55 | 1.08 | 3.95 |
| | M | 3.25 | 1.08 | 2.28 | .34 | |
| | σ | 4.73 | 2.58 | 4.06 | .88 | |

## Table XVI

## SUMMARY OF ANALYSIS OF VARIANCE (TYPE III) FOR N/? ERRORS

| Source | df | ms | F |
|---|---|---|---|
| Between subjects | (55) | | |
| Anxiety (A) | 1 | 20.205 | 2.278 |
| Intelligence (I) | 1 | 7.657 | |
| A X I | 1 | 35.439 | 3.995 |
| Error between | 52 | 8.869 | |
| Within subjects | (56) | | |
| Task (T) | 1 | 118.082 | 8.387 ** |
| T X A | 1 | .370 | |
| T X I | 1 | 4.842 | |
| T X A X I | 1 | 8.578 | |
| Error within | 52 | 14.079 | |

**P < .01

## Appendix H

## Table XVII

## FREQUENCY OF SUBJECTS IN EACH SUBJECT GROUP WHO ATTAINED EACH OF THE CORRECT CONCEPTS

| | | Hi A | | Lo A | |
|---|---|---|---|---|---|
| | Task: | 1 | 2 | 1 | 2 |
| Hi IQ | No. of Ss | 13 | 13 | 11 | 14 |
| Lo IQ | No. of Ss | 6 | 7 | 12 | 12 |

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The Effects of Group Counseling on the Academic Performance of Anxious College Freshmen (with C. D. Spielberger and H. Weitz). J. counsel. Psychol. In press.

Personality characteristics of anxious college students who voluntarily participated in an academic orientation counseling program. Paper read at Southeastern Psychological Assoc. meetings, Gatlinburg, April, 1961.

Variables contributing to perceptual-motor performance deficits in brain damage (with O. A. Parsons). Paper read at Southwestern Psychological Assoc. meetings, Little Rock, April, 1961.

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